Pupil Remapping (PIAA) Coronagraph : a high performance Coronagraph for a smaller, simplier TPF

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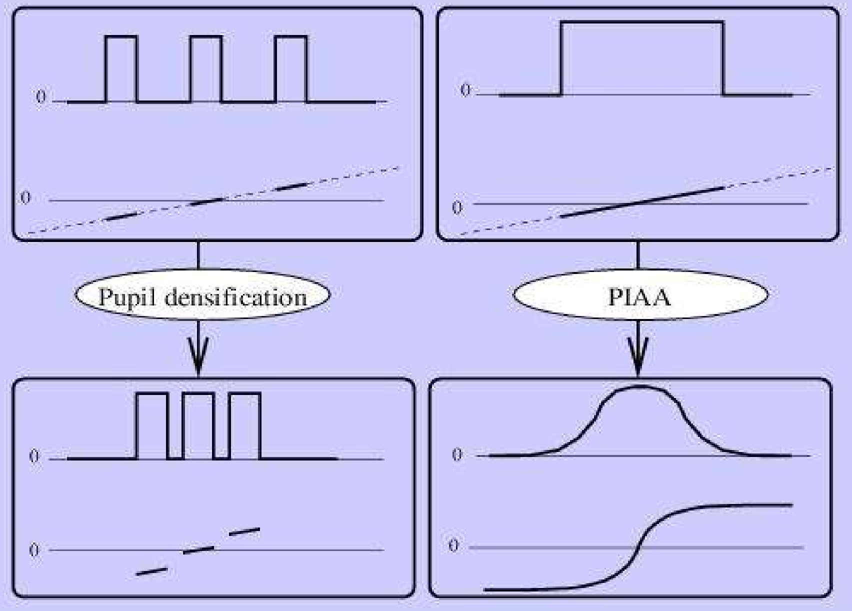
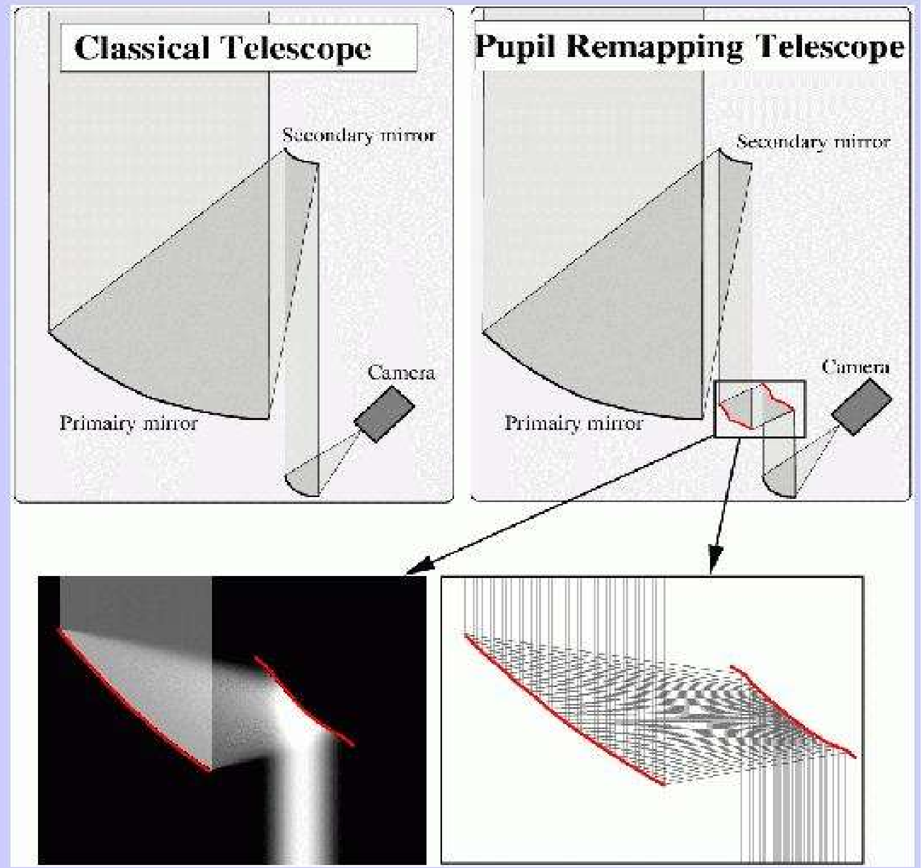
What is Pupil Remapping ?

Pupil remapping : changing the light distribution in the Pupil plane using geometrical optics. Pupil remapping can be used to produce a PSF suitable for High Contrast imaging.

On interferometers: Pupil Densification
On single pupil telescope: PIAA

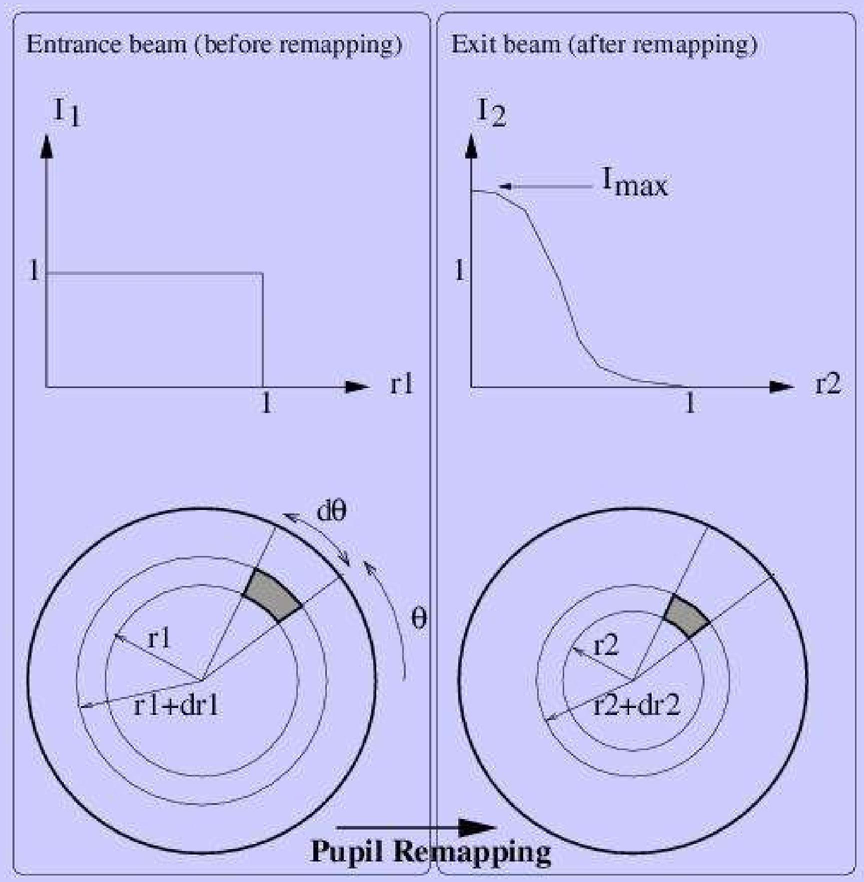




Pupil Remapping on single pupil telescopes (PIAA)

PIAA uses 2 optics (lenses or, ideally, mirrors) to change the radial profile of a beam by redistribution of the light in the pupil plane
It can be used to efficiently apodize a telescope pupil, without loss of flux, angular resolution or discovery space.

PIAA is also compatible with elliptical pupils.
Although PIAA can remove central abstruction and spiders, the optics are then difficult to polish and phase steps appear in the wavefront of off–axis sources

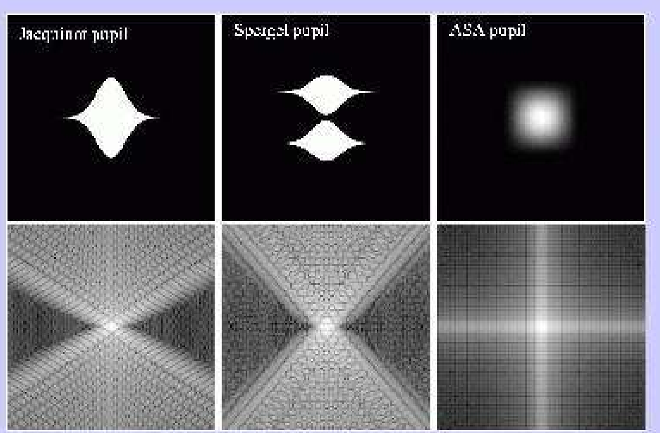


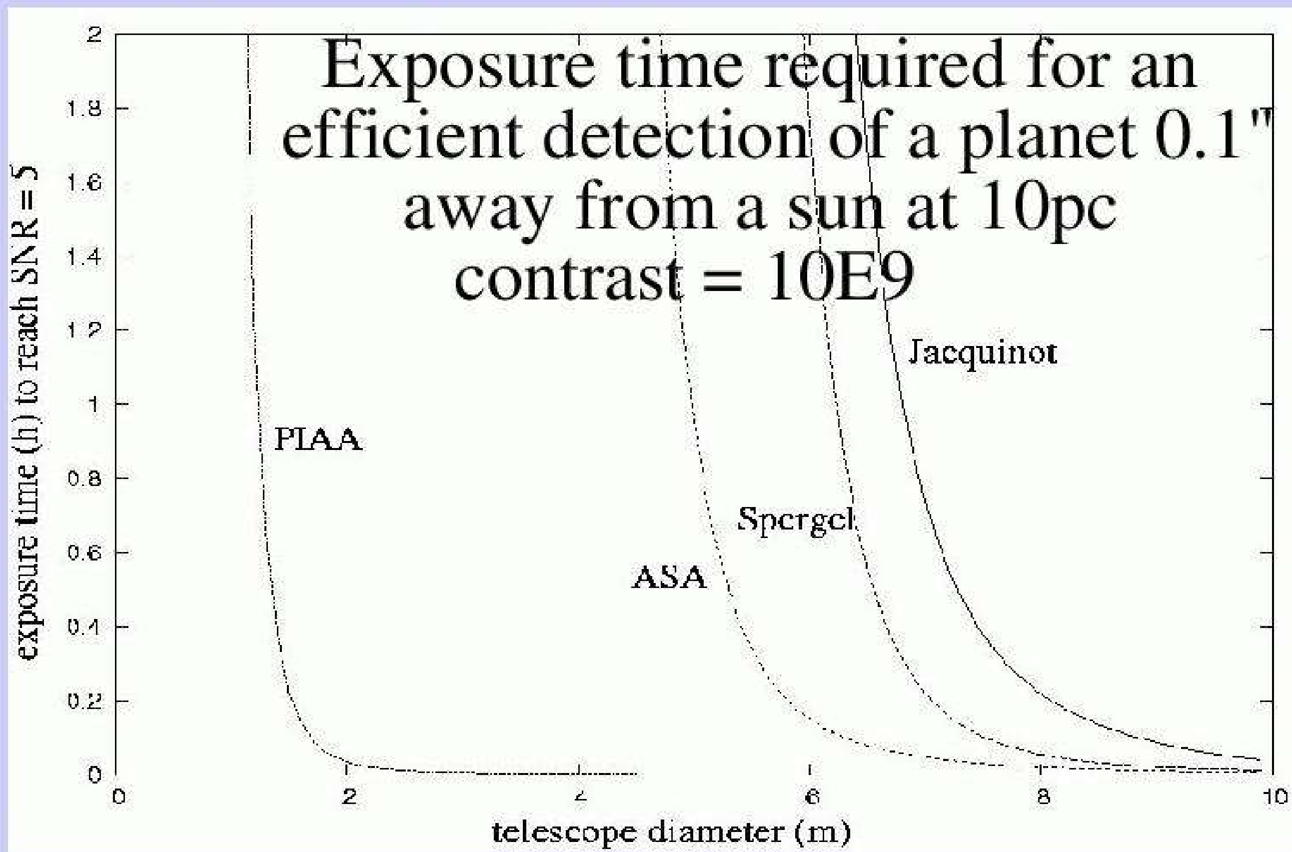
Powerfull alternative to classical pupil apodization techniques:

- preserves the angular resolution and sensitivity of the telescope
- achromatic technique (unless lenses are used)
- delivers images: can be compatible with coronagraphs
- can efficiently detect planets at small angular separations (~ λ/d)
- not affected by the stellar diameter

A 2m optical Pupil Remapping telescope in space can fullfill the TPF goals.

	Transmission	IWD	Discovery Space
PIAA	1.00	$\approx 1.5\lambda/d$	1.00
Jacquinot	0.285	$\approx 5\lambda/d$	≈ 0.25
Spergel	0.273	$\approx 4\lambda/d$	≈ 0.5
ASA	0.107	$\approx 4\lambda/d$	≈ 0.5 (increases with distance)

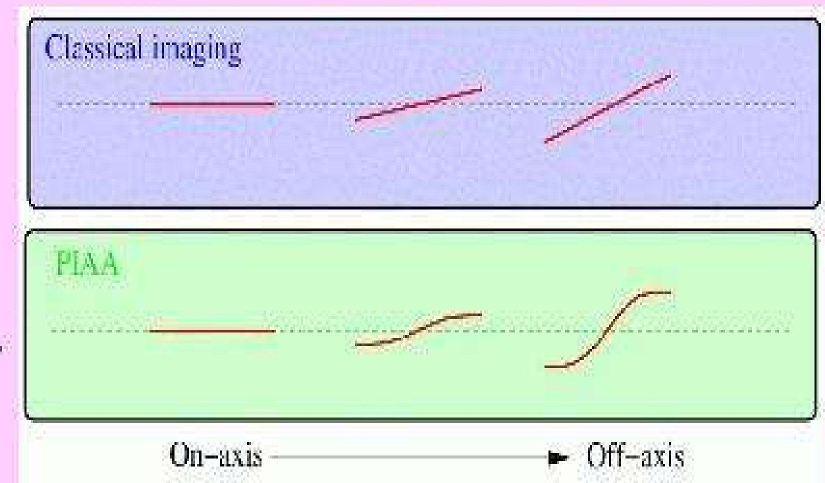




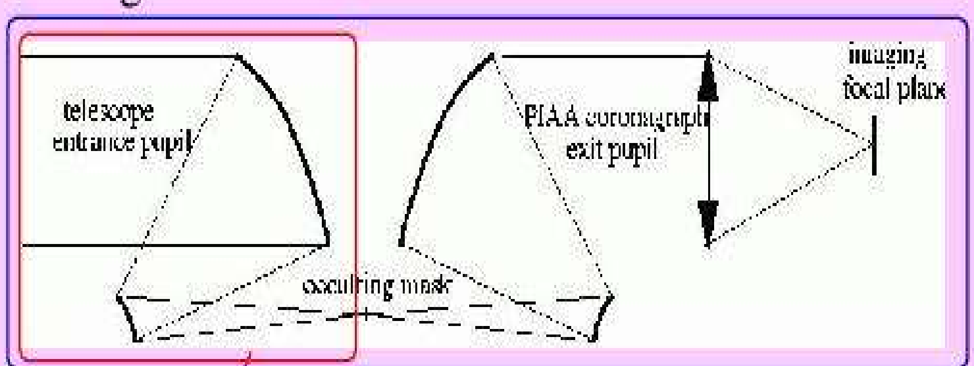
Field of view effects

PIAA Imager and PIAA Coronagraph

The remapping of the pupil preserves the wavefront flatness for an on–axis source, but the output wavefront of an off–axis source is no longer a tilted flat wavefront.

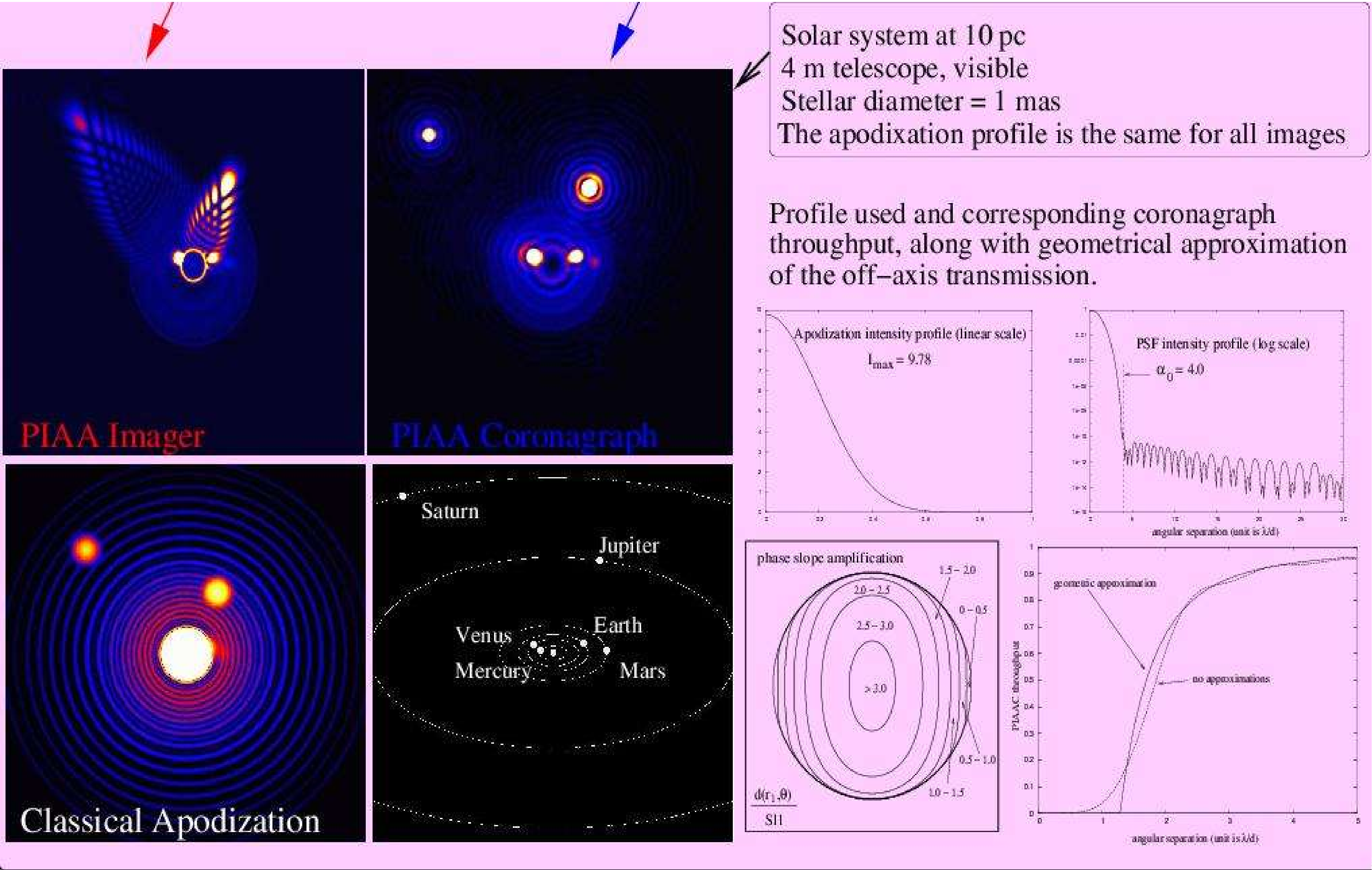


As a consequence, the image of an off–axis source contains aberrations. These aberrations are not critical for the detection sensitivity of very close companions, but they reduce the effective field of view of the image.



An easy solution to this problem is to use an occulting mask in the focal plane immediately after the apodizing optics, and then to cancel the aberrations of off–axis sources by "de–apodizing" the beam with a second set of optics. This second set of non–coronagraphic optics can be of much lower optical quality than the first 2 mirrors.

Performance



Laboratory work

- preliminary tests have validated the concept (see poster presented by R. Galicher) with lenses.
- Higher optical quality mirrors will be tested in the lab to demonstrate high contrast imaging.

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